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## Chloroplast-transgenic plants are not a gene flow panacea

*To the editor:*

The assertion has been made recently by Daniell et al.[1] that chloroplast (cp) transformation will be a practical solution to the problem of crop transgenes flowing to related weeds. This is an overstatement. They argued that transformed cp DNA, which they apparently assumed to be exclusively maternally inherited, will not be prone to gene flow through pollen transfer and hybridization compared with genes that are transformed into plant nuclear DNA. From this basis, their report claims that transgenes engineered into the plant cp genome will be biologically contained. While in many species cp transformation will help contain transgenes, this putative panacea is plagued with problems.


The first problem is that cps are not always maternally inherited. The best-studied group in this respect has been the conifers[2,3], which have paternal inheritance of plastids. Many plants have biparental transmission of plastids. Ironically, tobacco[4,5] is one plant in which cp can be transmitted via pollen. The crop plant alfalfa[6-8] has also been found to have biparental inheritance of chloroplasts.

The second problem is that weedy relatives can act as pollen donors and move weed genes into the "safe" cp-transformed plants, resulting in transgenic weeds. Through repeated backcrosses to weeds, with weeds acting as pollen donors, it is quite possible to introgress the transformed cps into a weed genetic background. Much work has been done in canola (oilseed rape, *Brassica napus*) to examine crop-to-weed gene flow. Most recently, Chevre et al.[9] introgressed wild radish, *Raphanus raphanistrum*, a troublesome weed, chromosomes into transgenic male-sterile canola using repeated backcrosses to canola as the female parent. In fact, this cross had higher hybridization and introgression rates compared with the reciprocal (with canola acting as the pollen donor)[10-12]. That canola has higher hybridization frequency as the pollen recipient has also been observed in canola crosses with other weedy Brassicas[13,14]. It is clear that related weed genes enter canola all the time via pollen. Thus, transgenic canola with transgenes in either cp or nuclear DNA will be prone (at a low level) to introgression of weed genes as a pollen recipient.

This said, the third problem is integrative. Overstating the biosafety of cp-transgenic crops with regard to gene flow could lead to policy mistakes and ecological problems. We would hope that assumptions of biosafety regarding gene flow using any system will be empirically tested and not treated as brute fact. Second, we hope that monitoring for transgene-introgressed weeds will become the norm for potentially problematic crops such as canola.

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*To the editor:*

There is chloroplast gene flow through pollen in higher plants. Two articles in *Nature Biotechnology*[1,2] make the blanket claim that there is a lack of gene flow through pollen. The original research was done with tobacco in which there is clear evidence of gene flow through tobacco pollen under selection pressure by a herbicide like drug tentoxin[3]. It is well known that chloroplasts are mainly inherited through pollen in conifers[4], while major crops such as alfalfa inherit plastids from both pollen and egg[5]. In rice there is occasional biparental inheritance of chloroplast genes[6], while in peas there is cultivar variability for the presence of plastid DNA in pollen[7]. Interestingly in rapeseed, paternal mitochondrial DNA was transferred to the egg but not paternal chloroplast DNA[8].

These are but a few references from a large literature showing that chloroplasts are inherited through pollen, pollen and egg, or selectively influenced by stress to transmit genes through pollen when maternal transmission is usual. Of course this is a "motherhood" issue, but it is clear that publicity claiming that plants do not inherit chloroplasts through pollen is just false, and a darn shocking falsehood, at that.

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## Genetic ID

*To the editor:*

I am writing to correct a number of inaccuracies in the article, "Firms sleuth out transgenic foods," (*Nature Biotechnology* **15:**1331, December 1997). A central theme in the article was that, although Genetic ID provides world-class GMO testing services, we subscribe to some pernicious political agenda. This is incorrect and misleading.

The article claims that TNO, a Dutch laboratory, had a nonexclusive licensing agreement with Genetic ID for GMO-testing technology and that they withdrew from this relationship because of Genetic ID's political agenda. In fact, the agreement with TNO was exclusive for the territory of Europe. Furthermore, this contract was terminated unilaterally, but not by TNO. Genetic ID terminated the agreement for purely business reasons.

We have in our files the contract with TNO, which clearly specifies the exclusivity of the relationship, as well as letters in which we stated our concerns about the deficiencies in TNO's marketing performance, which precipitated our decision to unilaterally terminate the relationship.

It should also be pointed out that TNO approached Genetic ID with the proposal to license Genetic ID's technology, and that, at the time they approached Genetic ID, they were well aware of the stories spread about me by certain segments of the biotechnology industry. These issues were an early and frank part of our discussions with TNO, and according to TNO's representatives, those discussions quickly laid their questions to rest. It is quite dismaying to find *Nature Biotechnology* publishing documentably erroneous statements that perpetuate those same inaccuracies.